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ABSTRACT

One-hundred twenty packages of computer programs, each package dealing with a single mathematical topic, are developed. Each package consists of three programs; the first gives the student a problem set, the second allows students to check answers, and the third composes a test. Topics range from addition of non-negative integers and other elementary topics to coordinate geometry, the binomial expansion, and other upper-level subjects. Experience indicates that even reluctant learners are motivated to use the system which is easy for both students and teachers to operate.
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Drill, Practice, and Testing Applications
for the Reluctant Learner and Teacher of Mathematics:
Elementary and Secondary

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The story you are about to hear originated in a local need. A number of school systems in North Carolina had gotten together to form a non-profit corporation called School Computer Service Corporation to provide economical computing for the instructional program and there was a need to supplement the practice exercises available to schools that were offering a course using the text A Second Course in Algebra and Trigonometry With Computer Programming.

Sets of three computer programs, written in the BASIC language, were produced. Under each topic the three programs were as follows:

- ° The first provided students with a set of problems. These were randomly produced so that no two students were likely to get the same set of problems.
- ° The second checked the work that the student had done by providing answers to his set of problems.
- ° The third tested and graded his knowledge of the topic.

Again, no two students were likely to get the same problem.

Originally it was thought that teachers might develop their own "sets of three." Consequently, a pattern was developed that might be followed by a teacher. Experience has shown that teachers do not have the time that is needed for this work. However, the development of a "set of three" has been

used very successfully as a project in college student seminars and teacher workshops where participants had very little previous experience of programming.

Over the past four years there has been an expansion to cover topics ranging from simple arithmetic through most high school algebra topics. There are now over 120 "sets of three." The programs are used in elementary schools, junior and senior high schools, and even in some colleges. Over the years, experience with the programs has resulted in refinement and personalizing of the programs as well as in instant feedback of the correct answer following an incorrect one in the tests.

Success has been particularly noteworthy among slow or reluctant learners. Many such students have been completely turned around as a result of using these programs. The following is an illustration of this type of success:

A teacher of first year algebra found that she had a group of students in her tenth grade class who showed total disinterest even to the point of not turning in any work (including tests). It had been felt that they should have a mathematics course and this was the only one available at the tenth grade level.

They were introduced to the terminal and became fascinated to the point that they would voluntarily go to the terminal room to work on their algebra. These students were often found working on their algebra for 45 minutes at a time and completely unsupervised. Prior to this, it is unlikely that any of them would have voluntarily worked for one minute on mathematics. They felt success, were making good grades, became eager to participate in class, and,

in addition, began to clean themselves up and dress more attractively. They soon eliminated their poor grades of the early weeks of the year and passed their course.

These students had not only felt success (evidently an element that had been lacking) but had gained some self-respect and, in taped interviews with some of them the following fall, they all strongly recommended that more teachers make use of the computer, and felt that without it they would not have passed their course. One who was interviewed volunteered the information that he thought that he would have forgotten everything by the fall but this was not so. He had run some of the tests and found that he was able to work the problems.

What happened to these students? Before getting involved with the computer it is unlikely that anyone would have given them jobs of responsibility. Following the computer experience, they were used as aides in the terminal room to assist their peers, and did a very fine job.

Experience has shown that, unfortunately, many teachers are reluctant to turn this type of student loose in the terminal room. Provided the orientation is handled carefully and the topic used in the orientation is simple enough for the student to succeed, there need be no fear.

Here is a list of the topics covered with the number of "sets of three" (varying in difficulty) under each topic:

TOPICS

Number

Number

Addition of Non-Negative Integers	9	Division of Polynomials	4
Subtraction of Non-Negative Numbers	3	Factoring:	
Multiplication of Non-Negative Integers	3	Trinomials	3
Division of Positive Integers	3	Difference of Two Squares	1
Finding All Pairs of Factors of Positive Integers	1	Sum of Two Cubes	1
Addition of Decimals	5	Difference of Two Cubes	1
Subtraction of Decimals	5	Exponents	2
Multiplication of Decimals	4	Quadratic Equations:	
Division of Decimals	4	Solving by Factoring	2
Least Common Denominator	1	Solving by Completing the Square	2
Greatest Common Divisor	1	Using the Discriminant	2
Reduction of Fractions to Lowest Terms	2	Vertex, Symmetry, Critical Value	1
Conversion of Fractions to Decimals	1	Synthetic Substitution or Division	3
Addition of Fractions	3	Analytics:	
Multiplication of Fractions	1	Coordinates of Mid-Point of Line Segment	1
Percentages	1	Slope of Line Segment	1
Simple Interest	1	Joining 2 Given Points	1
Addition of Signed Numbers	1	Slope of Perpendicular to Line Joining 2 Points	1
Subtraction of Signed Numbers	1	Equation of Perp. Bisector of Line Segment	1
Multiplication of Signed Numbers	1	Circles:	
Division of Signed Numbers	1	Finding Center and Radius Given Equation	1
Addition of Algebraic Expressions	1	Finding Equation Given Center and Radius	1
Subtraction of Algebraic Expressions	1	Ellipses:	
Rounding Off Numbers	1	Equation, Intercepts, Foci	1
Writing Equations in Form $y=ax + b$	2	Complex Numbers	6
Finding Slope and Y-intercept Given Linear Equation	2	Logarithms	5
Finding Linear Equation Given Slope and Y-intercept	3	Arithmetic Sequences	1
Grouping Symbols	1	Geometric Sequences	1
Solving:		Probability	1
Linear Equations	1	Rth Term of Binomial Expansion	1
Linear Inequalities	1	Determinant of 3 x 3 Matrix	1
Systems of Two Linear Equations	1	Rational Roots of Cubic Equations	2
Systems of Three Linear Equations	2	Trigonometric Ratios	1
Products of Binomials	1	Cartesian Products	1
Products of Trinomials by Binomials	1	Permutations	1
		Combinations	1

Now let us take a specific set, the first in a series on multiplication of non-negative integers.

Here is a RUN of the problem program. You will note that the instructions are brief and include the name of the check program to be called on completion of the work. The student will have been informed that the asterisk is used to indicate multiplication.

MULTPI 10:45 WED. 10-20-76

FIND THE FOLLOWING 10 PRODUCTS, THEN CALL MULTCI*** AND CHECK YOUR ANSWERS.

- | | | | | |
|------------|------------|------------|------------|-------------|
| 1. $5 * 2$ | 2. $4 * 3$ | 3. $6 * 8$ | 4. $7 * 6$ | 5. $9 * 3$ |
| 6. $6 * 5$ | 7. $1 * 4$ | 8. $7 * 4$ | 9. $8 * 3$ | 10. $9 * 1$ |

RUNS of the check and test programs follow.

The check program (MULTC1) has been modified here to fit on one page (checks only 8 of the answers). In the check program you will note that the student has the option of requesting instructions or not. The first time a student runs a program he is encouraged to answer "Yes"; thereafter, of course, he does not require the instructions. The comments at the end of the program are self-explanatory.

In the third in the set, the test, you will note the personalizing that occurs here. You may also note that the student is spoken to by name when he gives an incorrect answer - to soften the blow? This is hardly necessary if the answer is correct! A very important feature of the test is the instant feedback of the correct answer when a mistake has been made - a feature that is not available under more traditional test conditions. In this way the test is also a learning experience.

MULTC1 11:02 WED. 10-20-76

THIS PROGRAM WILL CHECK YOUR ANSWERS TO THE PROBLEMS
THAT WERE GIVEN TO YOU BY THE PROGRAM MULTP1*** .

DO YOU NEED INSTRUCTIONS?YES

IN ANSWER TO THE QUESTION 'WHAT ARE THE FACTORS IN THE
FIRST PROBLEM?', IF THE PROBLEM WERE $5 * 7$ YOU WOULD TYPE
5,7 AND PRESS THE RETURN KEY. THE COMPUTER WOULD THEN
GIVE YOU THE CORRECT ANSWER.

WHAT ARE THE FACTORS IN THE FIRST PROBLEM?5,2

YOUR PRODUCT SHOULD BE: 10

NEXT PROBLEM?4,8

YOUR PRODUCT SHOULD BE: 32

NEXT PROBLEM?6,8

YOUR PRODUCT SHOULD BE: 48

NEXT PROBLEM?7,6

YOUR PRODUCT SHOULD BE: 42

NEXT PROBLEM?9,3

YOUR PRODUCT SHOULD BE: 27

NEXT PROBLEM?6,5

YOUR PRODUCT SHOULD BE: 30

NEXT PROBLEM?1,4

YOUR PRODUCT SHOULD BE: 4

NEXT PROBLEM?7,4

YOUR PRODUCT SHOULD BE: 28

IF YOU HAVE DONE WELL ON THESE PROBLEMS AND FEEL
CONFIDENT ABOUT FINDING PRODUCTS OF THIS TYPE THEN CALL
MULTT1*** . THIS IS A TEST. IF YOU NEED MORE PRACTICE
CALL MULTP1*** FOR MORE PROBLEMS.

MULTI! 11:06 WED. 10-20-76

THIS PROGRAM WILL TEST YOU TO FIND OUT HOW WELL YOU CAN
FIND PRODUCTS OF NUMBERS.

WHAT IS YOUR NAME? JOE

DO YOU NEED INSTRUCTIONS, JOE? YES

WHEN THE COMPUTER GIVES YOU A PROBLEM, JOE, YOU MAY USE A
PIECE OF SCRATCH PAPER TO FIND THE INFORMATION THAT THE
COMPUTER ASKS FOR. THE COMPUTER WILL KEEP COUNT OF YOUR
SCORE AND WILL GIVE YOU A GRADE AT THE END. YOU SHOULD THEN
TAKE THIS GRADE TO YOUR TEACHER.

FIND THE FOLLOWING PRODUCT THEN TYPE YOUR ANSWER AND
PRESS RETURN:

3 * 9 272

CORRECT. VERY GOOD. 10 POINTS.

9 * 3 227

NEXT PROBLEM:

CORRECT. VERY GOOD. 10 POINTS.

2 * 4 25

NEXT PROBLEM:

YOUR ANSWER IS NOT CORRECT, JOE. IT SHOULD BE 8

4 * 5 220

TRY ANOTHER PROBLEM:

CORRECT. VERY GOOD. 10 POINTS.

2 * 1 22

NEXT PROBLEM:

CORRECT. VERY GOOD. 10 POINTS.

9 * 3 224

NEXT PROBLEM:

CORRECT. VERY GOOD. 10 POINTS.

6 * 6 236

NEXT PROBLEM:

CORRECT. VERY GOOD. 10 POINTS.

8 * 4 232

NEXT PROBLEM:

CORRECT. VERY GOOD. 10 POINTS.

8 * 7 256

NEXT PROBLEM:

CORRECT. VERY GOOD. 10 POINTS.

9 * 2 218

NEXT PROBLEM:

CORRECT. VERY GOOD. 10 POINTS.

YOU HAVE COMPLETED THE TEST AND YOUR SCORE IS 90

IF THIS IS NOT A SATISFACTORY GRADE, JOE, SEE YOUR TEACHER
OR CALL MULTI*** AGAIN.

Now let us take a quick look at some other sets.

First: Addition of algebraic expressions. In this set, Joe scored 100 on the test and you see how the computer congratulates him.

ADDNPR 11:16 WED. 10-20-76

ADD THE ALGEBRAIC EXPRESSIONS IN THE FOLLOWING PROBLEMS,
THEN CALL ADDNCK*** AND CHECK YOUR ANSWERS.

$$\begin{array}{r} 1. \quad -3A + -2B \\ \quad -5A + -1B \\ \hline \end{array}$$

$$\begin{array}{r} 2. \quad 3A + -3B + -3C \\ \quad 2A + -5B + 2C \\ \hline \end{array}$$

$$\begin{array}{r} 3. \quad -5X+2 + -5X + -5 \\ \quad -2X+2 + -3X + 3 \\ \hline \end{array}$$

$$\begin{array}{r} 4. \quad -5Y+2 + 2Y + 4 \\ \quad -4Y+2 + 3Y + -2 \\ \hline \end{array}$$

$$\begin{array}{r} 5. \quad -2A + 1B \\ \quad 5A + -4B \\ \quad -5A + 5B \\ \hline \end{array}$$

$$\begin{array}{r} 6. \quad -4Y+2 + -4Y + -2 \\ \quad -3Y+2 + -1Y + 1 \\ \quad 1Y+2 + 1Y + 2 \\ \hline \end{array}$$

ADDNCK 11:10 WED. 10-20-76

THIS PROGRAM WILL CHECK THE ANSWERS TO THE 6 PROBLEMS YOU WERE GIVEN BY THE PROGRAM ADDNPR***.

DO YOU NEED INSTRUCTIONS?YES

IN ANSWER TO THE QUESTION 'WHAT ARE THE COEFFICIENTS IN PROBLEM 1?', IF THE PROBLEM WERE:

$$\begin{array}{r} 3A + -4B \\ -2A + 1B \\ \hline \end{array}$$

YOU WOULD TYPE 3,-4,-2,1 IN THAT ORDER AND PRESS RETURN. THE COMPUTER WOULD THEN GIVE YOU THE CORRECT ANSWER.

WHAT ARE THE COEFFICIENTS IN PROBLEM 1 ?-3,-2,-5,-1

YOUR ANSWER SHOULD BE: $-3 A + -3 B$

WHAT ARE THE COEFFICIENTS IN PROBLEM 2 ?3,-3,-3,2,-5,2

YOUR ANSWER SHOULD BE: $5 A + -3 B + -1 C$

WHAT ARE THE COEFFICIENTS IN PROBLEM 3 ?-5,-5,-5,-2,-3,2

YOUR ANSWER SHOULD BE: $-7 X^2 + -3 X + -2$

WHAT ARE THE COEFFICIENTS IN PROBLEM 4 ?-5,2,4,-4,3,-2

YOUR ANSWER SHOULD BE: $-9 X^2 + 5 X + 2$

WHAT ARE THE COEFFICIENTS IN PROBLEM 5 ?-2,1,5,-4,-5,8

YOUR ANSWER SHOULD BE: $-2 A + 2 B$

WHAT ARE THE COEFFICIENTS IN PROBLEM 6 ?-4,-4,-2,-3,-1,1,1,2

YOUR ANSWER SHOULD BE: $-6 X^2 + -4 X + 1$

IF YOU HAVE DONE WELL ON THESE PROBLEMS AND FEEL CONFIDENT ABOUT FINDING SUMS OF ALGEBRAIC EXPRESSIONS THEN CALL ADDNT1***. THIS IS A TEST ON THIS TYPE OF PROBLEM. IF YOU NEED MORE PRACTICE RECALL ADDNPR*** FOR MORE PROBLEMS.

ADDNT1 11:23 WED. 10-20-76

THIS PROGRAM WILL TEST YOU TO FIND OUT HOW WELL YOU CAN
ADD ALGEBRAIC EXPRESSIONS.

WHAT IS YOUR NAME? JOE

DO YOU NEED INSTRUCTIONS, JOE? NO

ADD THE FOLLOWING ALGEBRAIC EXPRESSIONS THEN TYPE THE
COEFFICIENTS IN YOUR ANSWER AND PRESS RETURN:

$$\begin{array}{r} 1. \quad -2A + 5B \\ \quad -5A + -4B \\ \hline \end{array}$$

WHAT ARE THE COEFFICIENTS IN YOUR ANSWER? -7, 1

YOUR ANSWER IS CORRECT. 20 POINTS.

NEXT PROBLEM:

$$\begin{array}{r} 2. \quad 5A + -3B + 2C \\ \quad -1A + -5B + -2C \\ \hline \end{array}$$

WHAT ARE THE COEFFICIENTS IN YOUR ANSWER? 4, -3, 0

CORRECT. VERY GOOD. 20 POINTS.

NEXT PROBLEM:

$$\begin{array}{r} 3. \quad -4X + 2 + -3Y + 3 \\ \quad 1X + 2 + 3Y + 1 \\ \hline \end{array}$$

COEFFICIENTS? 3, 0, 4

CORRECT. GOOD WORK, JOE. 20 POINTS.

NEXT PROBLEM:

$$\begin{array}{r} 4. \quad 1X + 2 + -3X + -4 \\ \quad -1X + 2 + 1X + -5 \\ \hline \end{array}$$

COEFFICIENTS? 0, -2, -9

CORRECT. GOOD WORK, JOE. 20 POINTS.

NEXT PROBLEM:

$$\begin{array}{r} 5. \quad 1X + 2 + -5X + -2 \\ \quad -3X + 2 + 5X + 5 \\ \hline \end{array}$$

COEFFICIENTS? -2, 0, 3

CORRECT. GOOD WORK, JOE. 20 POINTS.

YOU HAVE COMPLETED THE TEST AND YOUR SCORE IS 100

Second - first to
you will enter that
the first

NOTE -

THE THE CHAIR
DATE OF CHAIR
ONE ANSWER.

1. 100, 10, 10, 10
2. 100, 10, 10, 10
3. 100, 10, 10, 10
4. 100, 10, 10, 10
5. 100, 10, 10, 10

GIVE ME ANOTHER
CORRECT

ANALC2 02:53 THU. 10-21-76

THIS PROGRAM WILL CHECK YOUR ANSWERS TO THE PROBLEMS
GIVEN YOU BY THE PROGRAM ANALC2***.

DO YOU NEED INSTRUCTIONS?

WHAT ARE THE COORDINATES IN THE FIRST PROBLEM? 2.6, 7, -1.6
YOUR SLOPE SHOULD BE -1.75

NEXT PROBLEM? 2.6, -4, 7
YOUR SLOPE SHOULD BE .25

NEXT PROBLEM? 2, -5, 3, 3
YOUR SLOPE SHOULD BE .40

NEXT PROBLEM? 5, 6, 2, 5
YOUR SLOPE SHOULD BE .33

NEXT PROBLEM? 6, 8, 1, 0
YOUR SLOPE SHOULD BE -1.14

NEXT PROBLEM? 6, 0, 4, 0
YOUR SLOPE SHOULD BE -.17

NEXT PROBLEM? 3, 0, -3, -4
YOUR SLOPE SHOULD BE .25

NEXT PROBLEM? 3, -1, -6, -5
YOUR SLOPE SHOULD BE .20

NEXT PROBLEM? 2, -2, 4, 7
YOUR SLOPE SHOULD BE .15

NEXT PROBLEM? 9, 3, -4, -3
YOUR SLOPE SHOULD BE -4.00

IF YOU HAVE DONE WELL ON THESE PROBLEMS AND FEEL
CONFIDENT ABOUT PROBLEMS OF THIS TYPE, CALL ANALC2***.
THIS IS A TEST. IF YOU NEED MORE PRACTICE, RECALL
ANALC2***.

ANALYZ 02:01 THU. 10-21-76

THIS PROGRAM WILL TEST YOU TO FIND OUT HOW WELL YOU CAN FIND THE SLOPE OF A LINE SEGMENT. YOU WILL BE GIVEN THE COORDINATES OF THE END POINTS OF THE LINE SEGMENT.

WHAT IS YOUR NAME (TYPE YOUR NAME AND PRESS RETURN) 12/12

DO YOU NEED INSTRUCTIONS, YES? 1

HERE IS THE FIRST PROBLEM: $(-6, -2)$, $(-1, 2)$
21.6

CORRECT. VERY GOOD. 10 POINTS.

NEXT PROBLEM: $(-3, 2)$, $(-6, 5)$
2-1.5

CORRECT. VERY GOOD. 10 POINTS.

NEXT PROBLEM: $(-4, 2)$, $(-6, -2)$
21

YOUR ANSWER IS INCORRECT, JES. IT SHOULD BE 2.5

TRY ANOTHER PROBLEM: $(-2, -2)$, $(-7, 4)$
22.6

CORRECT. VERY GOOD. 10 POINTS.

NEXT PROBLEM: $(-5, -2)$, $(-3, -2)$
21

YOUR ANSWER IS INCORRECT, JES. IT SHOULD BE -0.1

TRY ANOTHER PROBLEM: $(-4, 2)$, $(-7, 1)$
22.67

CORRECT. VERY GOOD. 10 POINTS.

NEXT PROBLEM: $(-2, -2)$, $(-3, -2)$
2-0.5

CORRECT. VERY GOOD. 10 POINTS.

NEXT PROBLEM: $(-3, 4)$, $(-5, 1)$
2-1.5

CORRECT. VERY GOOD. 10 POINTS.

NEXT PROBLEM: $(-7, -5)$, $(-6, 4)$
2-11

CORRECT. VERY GOOD. 10 POINTS.

NEXT PROBLEM: $(-1, 1)$, $(-7, 4)$
21

YOUR ANSWER IS INCORRECT, JES. IT SHOULD BE 0.2

YOU HAVE COMPLETED THE TEST AND YOUR SCORE IS 70

IF THIS IS NOT A SATISFACTORY GRADE, JES, SEE YOUR TEACHER OR CALL ANALYZ*** FOR MORE PRACTICE.

Lastly: Find the rational roots of second and third degree polynomial equations. In this set you will note that the check program provides the student with information (the "possible" roots) leading to the "actual" roots.

RATPR2 02:15 THU. 10-01-76

FIND ALL RATIONAL ROOTS OF THE FOLLOWING EQUATIONS, THEN
CALL RATPC2*** TO CHECK YOUR ANSWERS.

1. $-4X^3 + -4X + -1 = 0$
2. $-4X^3 + -4X^2 + -7X + -2 = 0$
3. $-3X^3 + -2X^2 + -3X + -2 = 0$

RATRC2 02:21 THU. 10-21-76

THIS PROGRAM WILL CHECK YOUR ANSWERS TO THE PROBLEMS GIVEN TO YOU BY THE PROGRAM RATRC2***.

DO YOU NEED INSTRUCTIONS?YES

IN ANSWER TO THE QUESTION, 'WHAT ARE THE COEFFICIENTS AND CONSTANT IN THE FIRST PROBLEM?', IF THE PROBLEM WERE $-3X^2 + 2X + 5 = 0$, YOU WOULD TYPE -3,2,5 AND PRESS RETURN. THE COMPUTER WILL THEN GIVE YOU THE CORRECT ANSWER.

DO YOU WANT A LIST OF POSSIBLE ROOTS AS WELL AS A LIST OF ACTUAL ROOTS?YES

WHAT ARE THE COEFFICIENTS AND CONSTANT IN THE FIRST PROBLEM?-4,-4,-1

THE POSSIBLE RATIONAL ROOTS ARE:

THE POSITIVE AND NEGATIVE VALUES OF:

1 / 1 1 / 2 1 / 4

THE RATIONAL ROOTS OF THE EQUATION ARE:

-.5 -.5

NEXT PROBLEM?-4,4,7,2

THE POSSIBLE RATIONAL ROOTS ARE:

THE POSITIVE AND NEGATIVE VALUES OF:

1 / 1 2 / 1 1 / 2 1 / 4

THE RATIONAL ROOTS OF THE EQUATION ARE:

2 -.5 -.5

NEXT PROBLEM?-2,2,3,2

THE POSSIBLE RATIONAL ROOTS ARE:

THE POSITIVE AND NEGATIVE VALUES OF:

1 / 1 2 / 1 1 / 2

THERE ARE NO RATIONAL ROOTS.

IF YOU HAVE DONE WELL IN THESE PROBLEMS AND FEEL CONFIDENT ABOUT WORKING THIS TYPE OF PROBLEM, THEN CALL RATRC2***. THIS IS A TEST. IF YOU NEED MORE PRACTICE, CALL RATRC2*** AGAIN.

BATST2 10:05 THU. 10-21-76

THIS PROGRAM WILL TEST YOU TO FIND OUT HOW WELL YOU CAN
FIND RATIONAL ROOTS OF POLYNOMIAL EQUATIONS.

WHAT IS YOUR NAME?JAE

DO YOU NEED INSTRUCTIONS, JAE?YES

WHEN THE COMPUTER GIVES YOU A PROBLEM, JAE, YOU MAY USE A
PIECE OF SCRATCH PAPER TO FIND THE INFORMATION THAT THE
COMPUTER ASKS FOR. THE COMPUTER WILL KEEP COUNT OF YOUR
SCORE AND WILL GIVE YOU A GRADE AT THE END. YOU SHOULD THEN
TAKE THIS GRADE TO YOUR TEACHER.

IN ANSWER TO THE QUESTION, 'HOW MANY ROOTS DO YOU HAVE?',
IF YOUR ROOTS WERE $-2, 1, 1$, YOU WOULD TYPE 3 AND PRESS
RETURN. IN ANSWER TO THE QUESTION, 'WHAT ARE YOUR ROOTS?',
YOU WOULD TYPE $-2, 1, 1$ AND PRESS RETURN. GIVE YOUR
ROOTS CORRECT TO TWO DECIMAL PLACES.

RATBT2 10:07 THU. 10-21-76

THIS PROGRAM WILL TEST YOU TO FIND OUT HOW WELL YOU CAN
FIND RATIONAL ROOTS OF POLYNOMIAL EQUATIONS.

WHAT IS YOUR NAME? JOE

DO YOU NEED INSTRUCTIONS, JOE? NO.

FIND THE RATIONAL ROOTS OF THE FOLLOWING EQUATION:
 $2X^2 + 7X + 3 = 0$

HOW MANY RATIONAL ROOTS DO YOU HAVE? 2

WHAT ARE YOUR ROOTS? -.5, -3
CORRECT. VERY GOOD. 20 POINTS.

NEXT PROBLEM:

$$-2X^2 + 15X + -6 = 0$$

HOW MANY RATIONAL ROOTS DO YOU HAVE? 2

WHAT ARE YOUR ROOTS? 2.67, 1
CORRECT. VERY GOOD. 20 POINTS.

NEXT PROBLEM:

$$-4X^3 + 3X^2 + -1X + -3 = 0$$

HOW MANY RATIONAL ROOTS DO YOU HAVE? 3

WHAT ARE YOUR ROOTS? -.5, 1.5, 1
CORRECT. VERY GOOD. 20 POINTS.

NEXT PROBLEM:

$$-12X^3 + 3X^2 + 5X + -2 = 0$$

HOW MANY RATIONAL ROOTS DO YOU HAVE? 3

WHAT ARE YOUR ROOTS? -.5, .67, .33
CORRECT. VERY GOOD. 20 POINTS.

NEXT PROBLEM:

$$-2X^3 + 40X^2 + -51X + -12 = 0$$

HOW MANY RATIONAL ROOTS DO YOU HAVE? 3

WHAT ARE YOUR ROOTS? -3, -.67, -1
CORRECT. VERY GOOD. 20 POINTS.

YOU HAVE COMPLETED THE TEST AND YOUR SCORE IS 100

EXCELLENT WORK, JOE

These "sets of three" are used very effectively in relation to class assignments

- 1) where the test is handed in;
- 2) with students requiring additional practice;
- 3) voluntarily by students preparing for a classroom test. If a good score can be made on the "set of three" test, then it is likely that the student will do well on his classroom test.

If a student does not do well on a "set of three" test, he can always take the test again (he will have a different set of problems). There is no objection to this because he is getting more practice. In fact there is much motivation here. Students, dissatisfied with their grade, will repeat the test until they have made 100 or some other grade that they regard as satisfactory.

And now a word about the teacher in relation to programs such as these. Many schools having access to a computer have "reluctant teachers" - teachers who are reluctant to make use of the computer. This, of course, is usually due to insecurity and lack of knowledge. The "sets of three" can be used very effectively with the absolute minimum of training - in fact, as long as the student can log on, call a program, and log off, the teacher is in business. Teachers normally would want to know how to do this themselves and usually to know a little more about what is going on. But, with the minimum of training for the teacher, these programs will support any text, teacher, or student. There is no requirement to follow a prescribed course determined by the programs - as in computer managed instruction. Any teacher can make immediate use of these "sets of three" or this MATHPACK - as the package is being called.

Ideally, these programs can free the teacher to teach while assignment of problems (each student having his own), checking of work, assigning tests (each student having his own) and grading, are handled by the computer with a few learning experiences thrown in (for example, instant feedback of correct answers.) And why "ideally"? Only because most schools would require more terminals than are currently available.